The paragraph beginning at page 2, line 31 and continuing through page 3, line 5:

B2

-- This transcoding might have to implement a spatial resolution reduction of the video in order to fit into the bandwidth of a particular receiver. For example, an ISDN subscriber might be transmitting video in Common Intermediate Format (CIF) (288x352 pixels), while a PSTN subscriber might be able to receive video only in a Quad Common Intermediate Format (QCIF) (144x176). Another example is when a particular receiver does not have the computational power to decode at a particular resolution and therefore a reduced resolution video has to be transmitted to that receiver. Additionally, transcoding of HDTV to SDTV requires a resolution reduction. --

IN THE CLAIMS:

Please substitute the following amended claims for corresponding claims previously presented. A copy of the amended claims showing current revisions is attached.

B3, cont'd

1. *(Amended)* An encoder or decoder, comprising:

- first processing circuitry for calculating a discrete cosine transform (DCT) of length N/2, N being a positive, even integer, to produce two sequences of coefficients of length N/2, that represent the first and second half, respectively, of an original sequence of values of length N, and

second processing circuitry for calculating a DCT of length N directly from the two sequences of coefficients of length N/2.

2. *(Amended)* An encoder or decoder comprising:

- first processing circuitry for calculating a discrete cosine transform (DCT) of length N/2 x N/2, N being a positive, even integer, to produce four sequences of coefficients, and

- second processing circuitry for calculating a DCT of length N x N directly from the four sequences of coefficients.

3. *(Amended)* The encoder or decoder of claim 1, wherein the second processing circuitry for calculating DCT of length N is arranged to calculate the even coefficients of the DCT of length N as:

$$X_{2k} = \sqrt{\frac{2}{N}}\varepsilon_{2k}\sum_{n=0}^{N-1} x_n \cos\frac{(2n+1)2\kappa\pi}{2N}$$

$$= \sqrt{\frac{2}{N}}\varepsilon_k \left\{ \sum_{n=0}^{\frac{N}{2}-1} x_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)} + \sum_{n=N/2}^{N-1} x_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)} \right\}$$

$$= \sqrt{\frac{2}{N}}\varepsilon_k \left\{ \sum_{n=0}^{\frac{N}{2}-1} y_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)} + \sum_{n=0}^{\frac{N}{2}-1} x_{N-1-n} \cos\left[\frac{[2(N-1-n)+1]\kappa\pi}{2(N/2)}\right] \right\}$$

$$= \sqrt{\frac{1}{2}} \left\{ \sqrt{\frac{2}{N/2}}\varepsilon_k \sum_{n=0}^{\frac{N}{2}-1} y_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)} + \sqrt{\frac{2}{N/2}}\varepsilon_k \sum_{n=0}^{\frac{N}{2}-1} z_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)} \right\}$$

$$= \sqrt{\frac{1}{2}}\left[Y_k + (-1)^k Z_k\right]$$

B3 cont'd

$$= \sqrt{\frac{1}{2}}\left[Y_k + Z'_k\right] \qquad k = 0,1,\ldots,(N/2)-1.$$

and the odd coefficients $R_k = X_{2k+1}$ as

$$R_k = R_k^{'} - R_{k-1}$$

where

$$R_k^{'} = \sqrt{\frac{2}{N}}\left\{ \sum_{n=0}^{N-1} x_n \cos\frac{(2n+1)(2k+1)\pi}{2N} + \sum_{n=0}^{N-1} x_n \cos\frac{(2n+1)(2k-1)\pi}{2N} \right\}$$

$$= \frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\left\{ \sqrt{\frac{2}{N/2}}\varepsilon_k \sum_{n=0}^{\frac{N}{2}-1} (y_n - z'_n) 2\cos\frac{(2n+1)\pi}{2N}\cos\frac{(2n+1)k\pi}{2(N/2)} \right\}$$

$$= \frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\left\{ \sqrt{\frac{2}{N/2}}\varepsilon_k \sum_{n=0}^{\frac{N}{2}-1} r_n \cos\frac{(2n+1)k\pi}{2(N/2)} \right\}$$

or

$$= \frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\ \{\text{ length-N/2 DCT-II of } r_n \}$$

where

$$r_n = (y_n - z'_n)2\cos\frac{(2n+1)\pi}{2N}$$

$$= \left\{\sqrt{\frac{2}{N/2}}\sum_{l=0}^{\frac{N}{2}-1}\varepsilon_l Y_l \cos\frac{(2n+1)l\pi}{2(N/2)} - \sqrt{\frac{2}{N/2}}\sum_{l=0}^{\frac{N}{2}-1}\varepsilon_l Z'_l \cos\frac{(2n+1)l\pi}{2(N/2)}\right\}2\cos\frac{(2n+1)\pi}{2N}$$

$$= \left\{\sqrt{\frac{2}{N/2}}\sum_{l=0}^{\frac{N}{2}-1}\varepsilon_l (Y_l - Z'_l)\cos\frac{(2n+1)l\pi}{2(N/2)} - \right\}2\cos\frac{(2n+1)\pi}{2N}$$

$$= g_n 2\cos\frac{(2n+1)\pi}{2N}$$

B3 concl.

where

g_n is a length-N/2 IDCT of $(Y_l - Z'_l)$, and where

$R'_k = X_{2k+1} + X_{2k-1}$.

or as

$$X_{2k+1} = \sqrt{\frac{2}{N}}\varepsilon_{2k+1}\sum_{i=0}^{N-1} x_i \cos\frac{(2i+1)(2\kappa+1)\pi}{2N}$$

$$= \sqrt{\frac{2}{N}}\left\{\sum_{i=0}^{\frac{N}{2}-1} x_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + \sum_{i=0}^{\frac{N}{2}-1} x_{i+N/2}\cos\frac{(2i+N+1)(2k+1)\pi}{2N}\right\}$$

$$= \sqrt{\frac{2}{N}}\left\{\sum_{i=0}^{\frac{N}{2}-1} y_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + \sum_{i=0}^{\frac{N}{2}-1} z_i \cos\left[\frac{(2i+1)(2k+1)\pi}{2N} + (k\pi + \frac{\pi}{2})\right]\right\}.$$

$$= \sqrt{\frac{2}{N}}\left\{\sum_{i=0}^{\frac{N}{2}-1} y_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + (-1)^{k+1}\sum_{i=0}^{\frac{N}{2}-1} z_i \sin\frac{(2i+1)(2k+1)\pi}{2N}\right\}$$

$$= \sqrt{\frac{2}{N}}(X1_k - (-1)^k X2_k), \quad k = 0,1,\ldots,(N/2)-1.$$

B4 concl.

4. *(Amended)* An encoder or decoder of claim 1, wherein N is equal to 2^m, m being a positive integer > 0.

Please cancel claims 5-8 without prejudice or disclaimer.

B5

9. *(Amended)* A transcoder comprising the encoder or decoder of claim 1.

B5 cont'd

10. *(Amended)* A system for transmitting DCT transformed image or video data comprising the encoder or decoder of claim 1.

11. *(Amended)* A method of encoding a digitalized image in a compressed discrete cosine transform (DCT) domain using DCTs of length N/2, comprising:

undersampling compressed frames by a certain factor in each dimension, and

calculating a DCT of length N x N directly from DCTs ~~for~~ of four adjacent blocks of size N/2 x N/2 of the digitalized image, N being a positive, even integer.

12. *(Amended)* A method of encoding a digitalized image represented as a discrete cosine transform (DCT) transformed sequence of coefficients of length N, N being a positive, even integer, comprising:

calculating a DCT of length N directly from two sequences of coefficients of length N/2,

B6 cont'd

wherein the two sequences of coefficients are obtained from DCTs of length N/2 and represent the first half and second half, respectively, of an original sequence of digitalized images values of length N.

13. *(Amended)* A method according to claim 12, wherein the even coefficients of the DCT of length N re calculated as:

$$
\begin{aligned}
X_{2k} &= \sqrt{\frac{2}{N}}\varepsilon_{2k}\sum_{n=0}^{N-1} x_n \cos\frac{(2n+1)2\kappa\pi}{2N} \\
&= \sqrt{\frac{2}{N}}\varepsilon_k\left\{\sum_{n=0}^{\frac{N}{2}-1} x_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)} + \sum_{n=N/2}^{N-1} x_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)}\right\} \\
&= \sqrt{\frac{2}{N}}\varepsilon_k\left\{\sum_{n=0}^{\frac{N}{2}-1} y_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)} + \sum_{n=0}^{\frac{N}{2}-1} x_{N-1-n} \cos\left[\frac{[2(N-1-n)+1]\kappa\pi}{2(N/2)}\right]\right\} \\
&= \sqrt{\frac{1}{2}}\left\{\sqrt{\frac{2}{N/2}}\varepsilon_k\sum_{n=0}^{\frac{N}{2}-1} y_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)} + \sqrt{\frac{2}{N/2}}\varepsilon_k\sum_{n=0}^{\frac{N}{2}-1} z_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)}\right\} \\
&= \sqrt{\frac{1}{2}}\left[Y_k + (-1)^k Z_k\right] \\
&= \sqrt{\frac{1}{2}}\left[Y_k + Z'_k\right] \qquad k = 0,1,\ldots,(N/2)-1.
\end{aligned}
$$

and the odd coefficients $R_k = X_{2k+1}$ as

$$R_k = R_k^{'} - R_{k-1}$$

where

$$R_k^{'} = \sqrt{\frac{2}{N}}\left\{\sum_{n=0}^{N-1} x_n \cos\frac{(2n+1)(2k+1)\pi}{2N} + \sum_{n=0}^{N-1} x_n \cos\frac{(2n+1)(2k-1)\pi}{2N}\right\}$$

$$= \frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\left\{\sqrt{\frac{2}{N/2}}\varepsilon_k \sum_{n=0}^{\frac{N}{2}-1}(y_n - z'_n)2\cos\frac{(2n+1)\pi}{2N}\cos\frac{(2n+1)k\pi}{2(N/2)}\right\}$$

$$= \frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\left\{\sqrt{\frac{2}{N/2}}\varepsilon_k \sum_{n=0}^{\frac{N}{2}-1} r_n \cos\frac{(2n+1)k\pi}{2(N/2)}\right\}$$

B4 cont'd

or

$$= \frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\ \{\text{ length-N/2 DCT-II of } r_n\,\}$$

where

$$r_n = (y_n - z'_n)2\cos\frac{(2n+1)\pi}{2N}$$

$$= \left\{\sqrt{\frac{2}{N/2}}\sum_{l=0}^{\frac{N}{2}-1}\varepsilon_l Y_l \cos\frac{(2n+1)l\pi}{2(N/2)} - \sqrt{\frac{2}{N/2}}\sum_{l=0}^{\frac{N}{2}-1}\varepsilon_l Z'_l \cos\frac{(2n+1)l\pi}{2(N/2)}\right\}2\cos\frac{(2n+1)\pi}{2N}$$

$$= \left\{\sqrt{\frac{2}{N/2}}\sum_{l=0}^{\frac{N}{2}-1}\varepsilon_l (Y_l - Z'_l)\cos\frac{(2n+1)l\pi}{2(N/2)} - \right\}2\cos\frac{(2n+1)\pi}{2N}$$

$$= g_n 2\cos\frac{(2n+1)\pi}{2N}$$

where

g_n is a length-N/2 IDCT of $(Y_l - Z'_l)$, and where

$R'_k = X_{2k+1} + X_{2k-1}$.

or as

B6 concl.

$$X_{2k+1} = \sqrt{\frac{2}{N}}\varepsilon_{2k+1}\sum_{i=0}^{N-1} x_i \cos\frac{(2i+1)(2\kappa+1)\pi}{2N}$$

$$= \sqrt{\frac{2}{N}}\left\{\sum_{i=0}^{\frac{N}{2}-1} x_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + \sum_{i=0}^{\frac{N}{2}-1} x_{i+N/2}\cos\frac{(2i+N+1)(2k+1)\pi}{2N}\right\}$$

$$= \sqrt{\frac{2}{N}}\left\{\sum_{i=0}^{\frac{N}{2}-1} y_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + \sum_{i=0}^{\frac{N}{2}-1} z_i \cos\left[\frac{(2i+1)(2k+1)\pi}{2N} + (k\pi + \frac{\pi}{2})\right]\right\}.$$

$$= \sqrt{\frac{2}{N}}\left\{\sum_{i=0}^{\frac{N}{2}-1} y_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + (-1)^{k+1}\sum_{i=0}^{\frac{N}{2}-1} z_i \sin\frac{(2i+1)(2k+1)\pi}{2N}\right\}$$

$$= \sqrt{\frac{2}{N}}(X1_k - (-1)^k X2_k), \quad k = 0,1,\ldots,(N/2)-1.$$

B7 concl.

14. *(Amended)* The method of claim 11, wherein N is equal to 2^m, m being a positive integer > 0.

15. *(Amended)* A method of decoding a digitalized image represented as a discrete cosine transform (DCT) transformed sequence of coefficients of length N, N being a positive, even integer, comprising:

calculating a DCT of length N from two sequences of coefficients of length N/2,

wherein the two sequences of coefficients represent the first half and second half, respectively, of an original sequence of digitalized image values of length N.

B8, contd

16. *(Amended)* A method of decoding a digitalized image in the compressed discrete cosine transform (DCT) domain using DCTs of lengths N/2, comprising:

undersampling compressed frames by a certain factor in each dimension, and

calculating a DCT of length N x N directly from DCTs for four adjacent blocks of sizes N/2 x N/2 of the digitalized image, N being a positive, even integer.

17. *(Amended)* The method of claim 15, wherein the even coefficients of the DCT of length N are calculated as:

$$X_{2k}=\sqrt{\frac{2}{N}}\varepsilon_{2k}\sum_{n=0}^{N-1}x_n\cos\frac{(2n+1)2\kappa\pi}{2N}$$

$$=\sqrt{\frac{2}{N}}\varepsilon_k\left\{\sum_{n=0}^{\frac{N}{2}-1}x_n\cos\frac{(2n+1)\kappa\pi}{2(N/2)}+\sum_{n=N/2}^{N-1}x_n\cos\frac{(2n+1)\kappa\pi}{2(N/2)}\right\}$$

$$=\sqrt{\frac{2}{N}}\varepsilon_k\left\{\sum_{n=0}^{\frac{N}{2}-1}y_n\cos\frac{(2n+1)\kappa\pi}{2(N/2)}+\sum_{n=0}^{\frac{N}{2}-1}x_{N-1-n}\cos\left[\frac{[2(N-1-n)+1]\kappa\pi}{2(N/2)}\right]\right\}$$

$$=\sqrt{\frac{1}{2}}\left\{\sqrt{\frac{2}{N/2}}\varepsilon_k\sum_{n=0}^{\frac{N}{2}-1}y_n\cos\frac{(2n+1)\kappa\pi}{2(N/2)}+\sqrt{\frac{2}{N/2}}\varepsilon_k\sum_{n=0}^{\frac{N}{2}-1}z_n\cos\frac{(2n+1)\kappa\pi}{2(N/2)}\right\}$$

$$=\sqrt{\frac{1}{2}}\left[Y_k+(-1)^k Z_k\right]$$

$$=\sqrt{\frac{1}{2}}\left[Y_k+Z'_k\right]\qquad k=0,1,\ldots,(N/2)-1.$$

B8, cont'd

and the odd coefficients $R_k = X_{2k+1}$ as

$$R_k = R'_k - R_{k-1}$$

where

$$R'_k=\sqrt{\frac{2}{N}}\left\{\sum_{n=0}^{N-1}x_n\cos\frac{(2n+1)(2k+1)\pi}{2N}+\sum_{n=0}^{N-1}x_n\cos\frac{(2n+1)(2k-1)\pi}{2N}\right\}$$

$$=\frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\left\{\sqrt{\frac{2}{N/2}}\varepsilon_k\sum_{n=0}^{\frac{N}{2}-1}(y_n-z'_n)2\cos\frac{(2n+1)\pi}{2N}\cos\frac{(2n+1)k\pi}{2(N/2)}\right\}$$

$$=\frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\left\{\sqrt{\frac{2}{N/2}}\varepsilon_k\sum_{n=0}^{\frac{N}{2}-1}r_n\cos\frac{(2n+1)k\pi}{2(N/2)}\right\}$$

or

$$=\frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\ \{\text{ length-N/2 DCT-II of } r_n\}$$

where

$$r_n = (y_n - z'_n)2\cos\frac{(2n+1)\pi}{2N}$$

$$= \left\{ \sqrt{\frac{2}{N/2}} \sum_{l=0}^{\frac{N}{2}-1} \varepsilon_l Y_l \cos\frac{(2n+1)l\pi}{2(N/2)} - \sqrt{\frac{2}{N/2}} \sum_{l=0}^{\frac{N}{2}-1} \varepsilon_l Z'_l \cos\frac{(2n+1)l\pi}{2(N/2)} \right\} 2\cos\frac{(2n+1)\pi}{2N}$$

$$= \left\{ \sqrt{\frac{2}{N/2}} \sum_{l=0}^{\frac{N}{2}-1} \varepsilon_l (Y_l - Z'_l) \cos\frac{(2n+1)l\pi}{2(N/2)} - \right\} 2\cos\frac{(2n+1)\pi}{2N}$$

$$= g_n 2\cos\frac{(2n+1)\pi}{2N}$$

where

B8 concl.

g_n is a length-N/2 IDCT of $(Y_l - Z'_l)$, and where

$R'_k = X_{2k+1} + X_{2k-1}$.

or as

$$X_{2k+1} = \sqrt{\frac{2}{N}} \varepsilon_{2k+1} \sum_{i=0}^{N-1} x_i \cos\frac{(2i+1)(2\kappa+1)\pi}{2N}$$

$$= \sqrt{\frac{2}{N}} \left\{ \sum_{i=0}^{\frac{N}{2}-1} x_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + \sum_{i=0}^{\frac{N}{2}-1} x_{i+N/2} \cos\frac{(2i+N+1)(2k+1)\pi}{2N} \right\}$$

$$= \sqrt{\frac{2}{N}} \left\{ \sum_{i=0}^{\frac{N}{2}-1} y_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + \sum_{i=0}^{\frac{N}{2}-1} z_i \cos\left[\frac{(2i+1)(2k+1)\pi}{2N} + (k\pi + \frac{\pi}{2}) \right] \right\}.$$

$$= \sqrt{\frac{2}{N}} \left\{ \sum_{i=0}^{\frac{N}{2}-1} y_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + (-1)^{k+1} \sum_{i=0}^{\frac{N}{2}-1} z_i \sin\frac{(2i+1)(2k+1)\pi}{2N} \right\}$$

$$= \sqrt{\frac{2}{N}} (X1_k - (-1)^k X2_k), \quad k = 0,1,\ldots,(N/2)-1.$$

B9 concl.

18. *(Amended)* The method of claim 15, N is equal to 2^m, m being a positive integer > 0.

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19. *(Amended)* A method of transcoding a digitalized image in the compressed discrete cosine transform (DCT) domain using DCTs of lengths N/2, comprising:

B10 cont'd

undersampling compressed frames by a certain factor in each dimension, and

calculating a DCT of length N x N directly from DCTs of length N/2 x N/2 for four adjacent blocks of size N/2 x N/2 of the digitalized image, N being a positive, even integer.

20. *(Amended)* An encoder comprising:

- means for performing discrete cosine transform (DCT) transformation of a sequence of values of length N/2 to produce two sequences of coefficients of length N/2, N being a positive, even integer, and

- means for calculating the DCT of length N directly from the two sequences of coefficients of length N/2 without having to calculate a DCT of length N,

B10 concl.

wherein the two sequences of coefficients represent the first half and second half, respectively, of an original sequence of values of length N.

21. *(Amended)* A method of encoding a digitalized image represented as an original sequence of values of length N, N being a positive, even integer, wherein the DCT of length N is calculated directly from two sequences of coefficients obtained from DCTs of sequence of values of length N/2 without having to calculate a DCT of length N, the two sequences representing the first half and second half, respectively, of the original sequence of values of length N.

Please add new claims 22-26 as follows:

22. *(New)* A method of transmitting a bit stream representing a digitalized image as a compressed video signal which includes coefficients obtained by calculating DCTs for blocks of size N/2 x N/2, the blocks being obtained by dividing the digitalized image, to a plurality of users, at least one of which requires a reduction of the bit stream or down-scaling of the corresponding compressed video signal, the method comprising:

B11 cont'd

receiving in a transcoder the bit stream of the compressed video signal;

extracting from the received bit stream the coefficients for the blocks of size N/2 x N/2;

collecting the extracted coefficients for four adjacent blocks of size N/2 x N/2, the groups of four adjacent blocks forming together non-overlapping blocks of size N x N in the digitalized image;

calculating, from the collected coefficients, coefficients of the DCTs for the blocks of size N x N using DCTs and IDCTs of length N/2 and without using DCTs or IDCTs of length N or using DCTs and IDCTs for blocks of the size N/2 x N/2 and without using DCTs or IDCTs of length N x N,

selecting, from the calculated coefficients, coefficients of the lowest frequencies; and

transmitting to the at least one user a bit stream including only the selected coefficients.

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23. *(New)* A method of transmitting a bit stream representing a digitalized image as a compressed video signal, which includes coefficients obtained by calculating DCTs for blocks of size N x N, the blocks being obtained by dividing the digitalized image, to a plurality of users, at least one of which requires a reduction of the bit stream or down-scaling of the corresponding compressed video signal, the method comprising:

receiving in a transcoder the bit stream of the compressed video signal;

extracting, from the received bit stream, the coefficients for the blocks of size N x N;

collecting the extracted coefficients for four adjacent blocks of size N x N, the groups of four adjacent blocks forming together non-overlapping blocks of size 2N x 2N in the digitalized image;

B'' cont'd

selecting, from the collected, extracted coefficients for each block of size N x N of each of the groups of four adjacent blocks of the size N x N, coefficients of N/2 x N/2 lowest frequencies;

calculating, from the selected coefficients for each of the groups, coefficients of the DCT for a block of size N x N using DCTs and IDCTs of length N/2 and without using DCTs or IDCTs of length N or using DCTs and IDCTs for blocks of size N/2 x N/2 and without using DCTs or IDCTs of length N x N, and

transmitting to the at least one user a bit stream including only the calculated coefficients.

24. *(New)* The method of claim 23, wherein, in the step of calculating coefficients of DCTs for blocks of size N x N the even coefficients of a DCT of length N is calculated as:

$$X_{2k} = \sqrt{\frac{2}{N}}\varepsilon_{2k}\sum_{n=0}^{N-1} x_n \cos\frac{(2n+1)2\kappa\pi}{2N}$$

$$= \sqrt{\frac{2}{N}}\varepsilon_k\left\{\sum_{n=0}^{\frac{N}{2}-1} x_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)} + \sum_{n=N/2}^{N-1} x_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)}\right\}$$

$$= \sqrt{\frac{2}{N}}\varepsilon_k\left\{\sum_{n=0}^{\frac{N}{2}-1} y_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)} + \sum_{n=0}^{\frac{N}{2}-1} x_{N-1-n} \cos\left[\frac{[2(N-1-n)+1]\kappa\pi}{2(N/2)}\right]\right\}$$

$$= \sqrt{\frac{1}{2}}\left\{\sqrt{\frac{2}{N/2}}\varepsilon_k\sum_{n=0}^{\frac{N}{2}-1} y_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)} + \sqrt{\frac{2}{N/2}}\varepsilon_k\sum_{n=0}^{\frac{N}{2}-1} z_n \cos\frac{(2n+1)\kappa\pi}{2(N/2)}\right\}$$

$$= \sqrt{\frac{1}{2}}\left[Y_k + (-1)^k Z_k\right]$$

B'' cont'd

$$= \sqrt{\frac{1}{2}}\left[Y_k + Z'_k\right] \qquad k = 0,1,\ldots,(N/2)-1.$$

and the odd coefficients $R_k = X_{2k+1}$ as

$$R_k = R_k^{'} - R_{k-1}$$

where

$$R_k^{'} = \sqrt{\frac{2}{N}}\left\{\sum_{n=0}^{N-1} x_n \cos\frac{(2n+1)(2k+1)\pi}{2N} + \sum_{n=0}^{N-1} x_n \cos\frac{(2n+1)(2k-1)\pi}{2N}\right\}$$

$$= \frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\left\{\sqrt{\frac{2}{N/2}}\varepsilon_k\sum_{n=0}^{\frac{N}{2}-1}(y_n - z'_n)2\cos\frac{(2n+1)\pi}{2N}\cos\frac{(2n+1)k\pi}{2(N/2)}\right\}$$

$$= \frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\left\{\sqrt{\frac{2}{N/2}}\varepsilon_k\sum_{n=0}^{\frac{N}{2}-1} r_n \cos\frac{(2n+1)k\pi}{2(N/2)}\right\}$$

or

$$= \frac{1}{\varepsilon_k}\sqrt{\frac{1}{2}}\ \{\text{ length-N/2 DCT-II of } r_n \}$$

where

$$r_n = (y_n - z'_n)2\cos\frac{(2n+1)\pi}{2N}$$

$$= \left\{ \sqrt{\frac{2}{N/2}} \sum_{l=0}^{\frac{N}{2}-1} \varepsilon_l Y_l \cos\frac{(2n+1)l\pi}{2(N/2)} - \sqrt{\frac{2}{N/2}} \sum_{l=0}^{\frac{N}{2}-1} \varepsilon_l Z'_l \cos\frac{(2n+1)l\pi}{2(N/2)} \right\} 2\cos\frac{(2n+1)\pi}{2N}$$

$$= \left\{ \sqrt{\frac{2}{N/2}} \sum_{l=0}^{\frac{N}{2}-1} \varepsilon_l (Y_l - Z'_l) \cos\frac{(2n+1)l\pi}{2(N/2)} - \right\} 2\cos\frac{(2n+1)\pi}{2N}$$

$$= g_n 2\cos\frac{(2n+1)\pi}{2N}$$

where

g_n is a length-N/2 IDCT of $(Y_l - Z'_l)$, and

$R'_k = X_{2k+1} + X_{2k-1}$,

B11 contd

or as

$$X_{2k+1} = \sqrt{\frac{2}{N}} \varepsilon_{2k+1} \sum_{i=0}^{N-1} x_i \cos\frac{(2i+1)(2\kappa+1)\pi}{2N}$$

$$= \sqrt{\frac{2}{N}} \left\{ \sum_{i=0}^{\frac{N}{2}-1} x_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + \sum_{i=0}^{\frac{N}{2}-1} x_{i+N/2} \cos\frac{(2i+N+1)(2k+1)\pi}{2N} \right\}$$

$$= \sqrt{\frac{2}{N}} \left\{ \sum_{i=0}^{\frac{N}{2}-1} y_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + \sum_{i=0}^{\frac{N}{2}-1} z_i \cos\left[\frac{(2i+1)(2k+1)\pi}{2N} + (k\pi + \frac{\pi}{2}) \right] \right\}.$$

$$= \sqrt{\frac{2}{N}} \left\{ \sum_{i=0}^{\frac{N}{2}-1} y_i \cos\frac{(2i+1)(2k+1)\pi}{2N} + (-1)^{k+1} \sum_{i=0}^{\frac{N}{2}-1} z_i \sin\frac{(2i+1)(2k+1)\pi}{2N} \right\}$$

$$= \sqrt{\frac{2}{N}} (X1_k - (-1)^k X2_k), \quad k = 0,1,\ldots,(N/2)-1.$$

25. *(New)* A transmission system for transmitting digitalized images where users are connected to each other through a multi-node control unit and bit streams of digitalized images corresponding to compressed video signals are transmitted between the users, the compressed video signal including coefficients obtained by calculating discrete cosine transforms (DCTs) for blocks of size N/2 x N/2 obtained by dividing the digitalized image,

- a first one of the users, for receiving a bit stream transmitted from a second one of the users, requiring a reduction of the bit stream or down-scaling of the corresponding compressed video signal,

the multi-node control unit comprising:

- means for receiving said bit stream from the second one of the users and for extracting from the bit stream coefficients for blocks of size N/2 x N/2 in a corresponding digitalized image;

- means for collecting the extracted coefficients for four adjacent blocks of size N/2 x N/2;

- means for calculating from the collected coefficients coefficients for a DCT for a block of size N x N using DCTs and IDCTs of length N/2 and without using DCTs or IDCTs of length N or using DCTs and IDCTs for blocks of size N/2 x N/2 and without using DCTs or IDCTs of length N x N;

- means for selecting, from the calculated coefficients, coefficients for the lowest frequencies, and

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- means for transmitting to the first one of the users a bit stream including only the selected coefficients.

26. *(New)* A transmission system for transmitting digitalized images, the system including users connected to each other through a multi-node control unit,

- bit streams of digitalized images being compressed video signals being transmitted between the users, the compressed video signal for a digitalized image comprising coefficients obtained by calculating DCTs for blocks of size N x N obtained by dividing the digitalized image,

- a first one of the users, for receiving a bit stream transmitted from a second one of the users, requiring a reduction of the bit stream or down-scaling of the corresponding compressed video signal,

the multi-node control unit comprising:

- means for receiving said bit stream from the second one of the users and for extracting from the bit stream coefficients for blocks of size N x N in a corresponding digitalized image;

- means for collecting the extracted coefficients for four adjacent blocks of size N x N;

- means for selecting, from the extracted coefficients for each of the four adjacent blocks, coefficients for N/2 x N/2 lowest frequencies;

- means for calculating, from the selected coefficients, coefficients for a DCT for a block of size N x N using DCTs and IDCTs of length N/2 and without using DCTs or IDCTs of length N

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